

BROOKHAVEN NATIONAL LABORATORY Safety & Health Services Division INDUSTRIAL HYGIENE GROUP Standard Operating Procedure: Program Procedure	NUMBER IH 75560
	REVISION Final Rev1
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1.0 PURPOSE & SCOPE

The purpose of this document is to provide a simple field procedure for operating the TSI Model 3007 Condensation Particle Counter (CPC) portable ambient air analyzer. With this document the user will be able to use the analyzer to capture environmental data and download all data collected for analysis. The procedure for operating the TSI Model 3007 CPC is based on the information provided in the operation and service manual.

This procedure provides a standardized method for monitoring ambient air in workplace environments to determine the concentration of nano-size particles present. This SOP describes procedures to measure particle concentrations for areas and can be used for background checks as well as during experimental operations. It should be used in conjunction with SOP [IH75180 Direct Reading Instruments](#), [IH51300 Chain of Custody Policy and Procedures](#) and [IH51660 Program Procedures: Instrument Calibration and Maintenance Program](#).

2.0 RESPONSIBILITIES

- 2.1 This program is implemented through the Safety & Health Services division (SHSD) Industrial Hygiene Group (IHG). Use of this SOP shall be limited to persons who act under the direction of a *competent hazard assessment person*.

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- 2.2 Persons using this procedure must have demonstrated competency to satisfactorily use this procedure and instrument to the satisfaction of the qualification criteria set in Section 7. Personnel that perform monitoring with this procedure are responsible to follow all steps indicated.
- 2.3 Persons conducting testing are responsible to document results of the testing in compliance with this SOP and *IH60500 Planning, Sampling, & Reporting Personnel Exposure Monitoring Results*. The data collected using this instrument must have appropriate evaluation of the hazard and risk by a *cognizant IH professional*.
- 2.4 Persons using this method and their supervisor are responsible to ensure that the appropriate personal protective equipment (PPE) is determined and worn while performing this procedure. In addition, the person performing the procedure and his/her supervisor are responsible to ensure that all required training and qualification for hazards that may be present in areas where this procedure will be used (such as respiratory protection or radioactive contamination) have been met.
- 2.5 The persons performing the procedure and their line supervisor are responsible to comply with all work planning and work permit system requirements.
- 2.6 The Industrial Hygiene Group shall maintain the equipment used in this procedure.

3.0 DEFINITIONS

- 3.1 ***Competent Hazard Assessment Person:*** A person from SHSD's Industrial Hygiene Group who is approved by the IHG management to use the CPC and analyze the results. Approval is based on formal education and experience with IH principles and nanomaterials.
- 3.2 ***Cognizant IH Professional:*** A person from SHSD's Industrial Hygiene Group who is approved by the IHG management to direct IH exposure monitoring assessments. Approval is based on formal education and experience with IH principles and knowledge of applicable occupational exposure limits.
- 3.3 ***Occupational Exposure Limit (OEL):*** The maximum time weighted average (TWA) exposure permitted for employee exposure, based on the lesser of the OSHA Permissible

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Exposure Limits (PEL) or ACGIH Threshold Limit Value (TLV). BNL follows the most protective OEL.

- 3.4 **Program Administrator:** A person designated by the IH Group Leader or SHSD management to administer this procedure and the associated program of data management.
- 3.5 **Qualified Sampler:** A person who has demonstrated competency, in accordance with Section 7, to perform this field procedure.

4.0 PREREQUISITES

- 4.1 Do not perform work using this procedure without meeting the training and qualification requirements.
- 4.2 Training for entry into restricted areas may be required (check with ESH coordinator or FS Representative for the facility). Use appropriate PPE for the area.

5.0 PRECAUTIONS

- 5.1 **Hazard assessment:** The actual task of using the instrument typically does not cause significant employee health risks. The CPC analyzer is intrinsically safe and is not capable of causing ignition of a mixture of flammable or combustible material in ambient air (as per NFPA Standard Number 493: *Intrinsically Safe Apparatus for use in Division 1 Hazardous Locations* 1978). This apparatus is suitable for use in Division 1 locations.
- 5.2 This unit uses isopropyl alcohol, which is flammable. In the quantities used in this instrument, the risk of an uncontrolled fire is very small. However, refer to the [*TSI MSDS*](#) for handling precautions and first aid procedures.
- Always recap the alcohol fill capsule and other containers immediately to prevent absorption of moisture and the escape of fumes. Do not use any alcohol which is visibly contaminated.
 - Never transport or store the CPC with the alcohol cartridge inside it. Flooding of the optics could occur.
 - Never leave the cartridge cavity open longer than necessary. Use the storage cap to cover the cartridge cavity when the CPC is transported or stored.

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- When the CPC is stored in the carrying case, store the cartridge in the fill capsule. Also, install the storage cap into the cartridge cavity to prevent dirt or lint from getting inside the CPC.

5.3 Personal Protective Equipment:

5.3.1 Operation of this analyzer does not require personal protective equipment. However, when filling the alcohol cartridge the work should be conducted using disposable gloves with an eye wash in the vicinity. The filling of the cartridge is not to be done near open flames or other ignition sources.

5.3.2 Since the purpose of this instrument is to collect information on airborne concentrations of nano-sized particles, the user must be familiar with the nanomaterial ES&H principles and BNL specific procedures as they are developed.

5.3.3 When the potential for exposure to airborne contaminants above the ACGIH TLV or STEL or OSHA PEL (which ever is lower) may occur in the area being sampled, the person collecting the sample must use appropriate respiratory protection in compliance with the [BNL Respiratory Protection Program](#).

5.3.4 When the potential for exposure to surface or airborne contaminants exist in the area being sampled, appropriate PPE for hands, feet, skin, head, or eyes may be needed for the area being entered. Check with your FS Representative or IH Group Leader

5.3.5 .

5.4 **Radioactive Contamination:** To avoid contamination of the CPC, this unit should not be used in areas where there is a potential for airborne radioactive particles.

5.5 **Work Planning:** All requirements of work permits and work planning system reviews must be met in performing this procedure.

5.6 **Environmental Impact and Waste Disposal:** This analyzer does not have adverse impact on the environment or generate hazardous wastes. The alcohol used in the CPC is released in miniscule quantities over the operation of the meter and has almost no environmental impact and will not approach occupational and environmental release regulatory levels. Refer to [IH50900 IH Group's EMS 14001 Program](#) for details on the environmental aspects of the CPC use.

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6.0 PROCEDURE

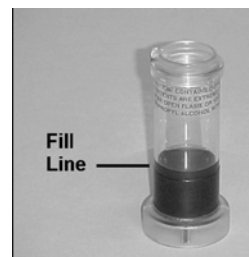
6.1 Equipment:

- 6.1.1 TSI Model 3007 CPC
- 6.1.2 Battery Holder
- 6.1.3 Spare Batteries (6 AA)
- 6.1.4 Carrying Case
- 6.1.5 AC Charger
- 6.1.6 TSI Approved Isopropyl Alcohol
- 6.1.7 Alcohol Fill Capsule
- 6.1.8 Alcohol Cartridge
- 6.1.9 30 ml alcohol bottle
- 6.1.10 Mesh Storage Bag
- 6.1.11 Spare wick kit,
- 6.1.12 computer cable,
- 6.1.13 HEPA zero filter and adaptor

Operate the analyzer as per this BNL Instrument Operation SOP.

6.2 Battery check

- Open the bottom panel of the meter and ensure the battery pack is installed. Ensure six (6) spare AA batteries are in the case.
- When using the AC adaptor the batteries are bypassed and will not charge.
- There is an internal battery that is not user replaceable. This battery maintains the logged data when the instrument is turned off or the batteries are being replaced.



6.3 Filling the Alcohol Capsule:

- 6.3.1 Turn the CPC off.
- 6.3.2 Open the alcohol fill capsule by twisting the storage cap counter-clockwise. Set the Storage cap down on a clean surface, with the end standing up.
- 6.3.3 Open the bottle of alcohol. Invert the bottle and insert the nozzle end into the alcohol fill capsule as far as possible to



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make certain that you cannot inadvertently spray alcohol anywhere except down into the capsule.

- 6.3.4 Squeeze alcohol into the alcohol fill capsule until the liquid level is even with the scribed fill-line near the base. Recap the alcohol bottle.
- 6.3.5 Make certain the alcohol cartridge is clean! Insert the alcohol cartridge into the alcohol fill capsule by aligning the groove with the pin and turning 1/8 turn clockwise until it locks into place.
- 6.3.6 Set the alcohol fill capsule down and wait a few minutes while the wick inside the cartridge soaks up alcohol.
- 6.3.7 Remove the cartridge from the capsule and gently shake it over the capsule to allow excess alcohol to drain back into the capsule. Stop when excess alcohol is no longer dripping. It is not necessary to wait until the outside surface of the alcohol cartridge is dry.
- 6.3.8 Insert the cartridge into the CPC. **DO NOT FORCE IT.** Align the tab on the cartridge with the tab on the CPC.
- 6.3.9 As you approach full insertion, firmly twist the cartridge clockwise about 1/8 turn. It should snap into position.
- 6.3.10 Recap the alcohol fill capsule using the storage cap.
 - Always recap the alcohol fill capsule and other containers immediately to prevent absorption of moisture and the escape of fumes. Do not use any alcohol which is visibly contaminated.
 - Never transport or store the CPC with the alcohol cartridge inside it. Flooding of the optics could occur.
 - Never leave the cartridge cavity open longer than necessary. Use the storage cap to cover the cartridge cavity when the CPC is transported or stored.
 - When the CPC is stored in the carrying case, store the cartridge in the fill capsule. Also, install the storage cap into the cartridge cavity to prevent dirt or lint from getting inside the CPC.



6.4 Turn On and Operation

- 6.4.1 The CPC can be used as a survey meter or data logger.
- 6.4.2 Turn the meter on by pushing in the **ON/OFF** button on the front of the instrument (hold for 2-3 seconds). The instrument will go through a warm-up period of approximately 600 seconds.
- 6.4.3 It will automatically begin monitoring in the survey mode. The real-time display is concentration in particles per cubic centimeter (pt/cc). The display is updated once each second.

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Note: The instrument must be maintained in a horizontal position at all times. Tilting the instrument for prolonged periods will flood the optics and require factory servicing. A tilt error message will be displayed, a beep sound, the pump stopped and the screen blanked if the instrument is tilted for more than 4 seconds. Upon return to horizontal, the unit will reset and begin monitoring again. It may be necessary to start logging mode again.

6.5 Perform Daily Zero Check: Once per day conduct this zero check to verify normal operations.

- 6.5.1 Turn on the instrument and let it warm-up.
- 6.5.2 Attach the zero filter assembly to the inlet screen assembly.
- 6.5.3 The pt/cc reading should go to zero in 5-10 seconds. Leave the filter attached for 30 seconds to ensure a stable reading.

6.6 Using the Keypad

- 6.6.1 The keypad has four arrows and an Enter key to move through the menus and select items.
- 6.6.2 The main menu has three options: Absolute Pressure; Setup; and Log Mode 1.
- 6.6.3 The Setup mode allows review of logged data, and can be used to change date/time, log interval, backlight interval; audio function and clearing memory.
- 6.6.4 The default values for log intervals are set at 1 second, or 1, 5, 15, and 30 minutes. The interval is a frequency and averaging period. As an example, when the interval is set to 5 minutes the reading will be recorded every 5 minutes and will be an average over the 5 minute period.
- 6.6.5 The backlight option adjusts the length of time the backlight stays on after a key is pressed or an alarm goes off. Prolonged use of the backlight may severely reduce the overall battery life.
- 6.6.6 Clearing the memory. Performing this step will erase **ALL** logged data files and is not reversible.
- 6.6.7 The Log Mode1 selection on the main menu allows selection of the logging mode (1, 2 or 3). Log Mode 1 is the default. Log Modes 2 & 3 are more sophisticated logging modes that require programming through the Aerosol Instrument Manager software.



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6.6.8 The Enter key will select the log mode and begin logging. The following screen will be displayed. Pressing the Enter key again will stop the log mode and return to survey mode.

4048		PT/CC
MIN 4032	08:32:00	
MAX 4950	09:27:00	
	98 % MEM	
LOG MODE 1	↵ TO STOP	

6.6.9 The Log Mode can store approximately 1000 hours of logged tests when recording at 1 minute intervals and may be separated into as many as 141 tests. Shorter logging intervals use memory more quickly.

6.7 **Recommended Maintenance:** The following list is the the factory recommended maintenance schedule.

- 6.7.1 Daily Zero Check – Before each use. (see Step 6.5)
- 6.7.2 Recharge the alcohol wick – Before each use (See Step 6.3)
- 6.7.3 Change the alcohol wick – As needed (see Troubleshooting App. 9.3) This should be performed by the IH Lab Manager
- 6.7.4 Factory Calibration and Cleaning - Annually

6.8 **Downloading data:** Return the unit to the IH Lab Manager for downloading data from the instrument.

6.9 **Results interpretation**

- 6.9.1 A *Cognizant IH Professional* should write a hazard evaluation report that evaluates the survey data, summarizes the potential for occupational exposure and compliance with OSHA and ACGIH Occupational Exposure Limits.
- 6.9.2 Ensure that a copy of the hazard evaluation report is sent to the IH Laboratory and is included in the ESHQ Directorate Recordkeeping system as per IH60500.
- 6.9.3 If the report indicates an over exposure to workers has occurred, prepare a summary of the written hazard evaluation report documenting worker's identity (BNL#) and exposure level relative to OEL to the Occupational Medicine Clinic.
- 6.9.4 For Personnel Monitoring: The hazard evaluation report and/or *5-Day Employee Notification Form* (see IH60500) must be used to inform all monitored

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employees of the results of the air sampling and the implication to compliance with occupational exposure limits.

- 6.9.5 Complete entry of data into the *IH Exposure Monitoring Database* as per IH60500.

7.0 IMPLEMENTATION AND TRAINING

- 7.1 Training prior to using this meter includes a demonstration of proper operation of the instrument based on training, education, and experience. All persons must have met the qualification criteria for IH75 Chemical Hazard Assessor set in *IH50300 BNL IH Program and IH Group Training & Qualification Matrix*.
- 7.2 Personnel are to document their training using Attachment 9.4 the Job Performance Measure Completion Certificate. Qualification on this JPM is required on a 3 year basis, providing the professional is monitoring noise sources frequently.

8.0 REFERENCES

- 8.1 Model 3007 Condensation Particle Counter Operation and Service Manual.

9.0 ATTACHMENTS

- 9.1 Measurement Principles
9.2 Condensation Particle Counter Parts
9.3 Troubleshooting Guide
9.4 Job Performance Measure (JPM) Qualification Certificate

10.0 DOCUMENTATION

Document Development and Revision Control Tracking		
Prepared By: (signature/date on file) J. Peters 07/07/06 Industrial Hygienist	Reviewed By / Date: (signature/date on file) Robert Selvey 07/07/06 Certified Industrial Hygienist	Approved By / Date: (signature/date on file) Robert Selvey 07/12/06 IH Group Leader

The only official copy is on-line at the SHSD IH Group website.
Before using a printed copy, verify that it is current by checking the document issue date on the website.

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ESH Coordinator/ Date: <i>none</i>	Work Coordinator/ Date: <i>none</i>	SHSD Manager / Date <i>none</i>
QA Representative / Date: (signature/date on file) <i>M. Pizzulli 07/15/06</i>	Training Coordinator / Date: <i>none</i>	Filing Code: IH52
Facility Support Rep. / Date: <i>none</i>	Environ. Compliance Rep. / Date: <i>none</i>	Effective Date: 07/12/06
ISM Review - Hazard Categorization <input type="checkbox"/> High <input type="checkbox"/> Moderate <input checked="" type="checkbox"/> Low/Skill of the craft	Validation: <input type="checkbox"/> Formal Walkthrough <input type="checkbox"/> Desk Top Review <input type="checkbox"/> SME Review Name / Date:	Implementation: Training Completed: Tracked in BTMS Procedure posted on Web: 07/19/06 Hard Copy files updated: 07/19/06

Revision Log		
Purpose: <input type="checkbox"/> Temporary Change <input type="checkbox"/> Change in Scope <input type="checkbox"/> Periodic review <input type="checkbox"/> Clarify/enhance procedural controls Changed resulting from: <input type="checkbox"/> Environmental impacts <input type="checkbox"/> Federal, State and/or Local requirements <input type="checkbox"/> Corrective/preventive actions to non-conformances <input type="checkbox"/> none of the above Section/page and Description of change: Based on a review by the SHSD QA Rep, minor text changes were made for typo and to expand some abbreviations and Acronyms for clarity. Text links to external documents were made. Titles and roles in the document were standardized or defined in section 3.		
R. Selvey 07/19/06 SME Reviewer/Date:	Reviewer/Date:	Reviewer/Date:

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Attachment 9.1

Measurement Principles

Laminar-flow Condensation Particulate Counters (CPCs) operate by drawing an aerosol sample continuously through a heated saturator, in which alcohol is vaporized and diffuses into the sample stream. Together, the aerosol sample and alcohol vapor pass into a cooled condenser where the alcohol vapor becomes supersaturated and ready to condense. Particles present in the sample stream serve as condensation sites for the alcohol vapor. Once condensation begins, particles grow quickly into larger alcohol droplets and pass through an optical detector where they are counted easily.

Particle size range is 0.01 to >1 micrometer (10 to 1000 nanometers) and the concentration range is 0 to 100,000 particles per cubic centimeter (pt/cc) with +/- 20% accuracy. Temperature range for use is 50 to 95° F. Battery life is reported to be approximately 5 hours of continuous use with 6 hours per fill of the alcohol.

The unit can be used in either the survey mode or logging mode. Logged data is downloaded to a computer using TSI's *Aerosol Instrument Manager Software*. Readings are in pt/cc and the unit is non-discriminatory for particular materials counting all particles passing through the detector.

A battery pack provides power for daily use. The system includes a separate charger/power supply which allows the analyzer to be powered from an ac supply. This allows the unit to be left in the logging mode for extended periods of time (multiple days).

The meter uses high purity isopropyl alcohol and must remain horizontal (display facing up) during use or damage can occur to the unit. During transport the alcohol must be removed from the unit to prevent leakage and damage to the optics inside the unit.

The following diagram shows the working components and the pathway through the unit.

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Safety & Health Services Division

INDUSTRIAL HYGIENE GROUP

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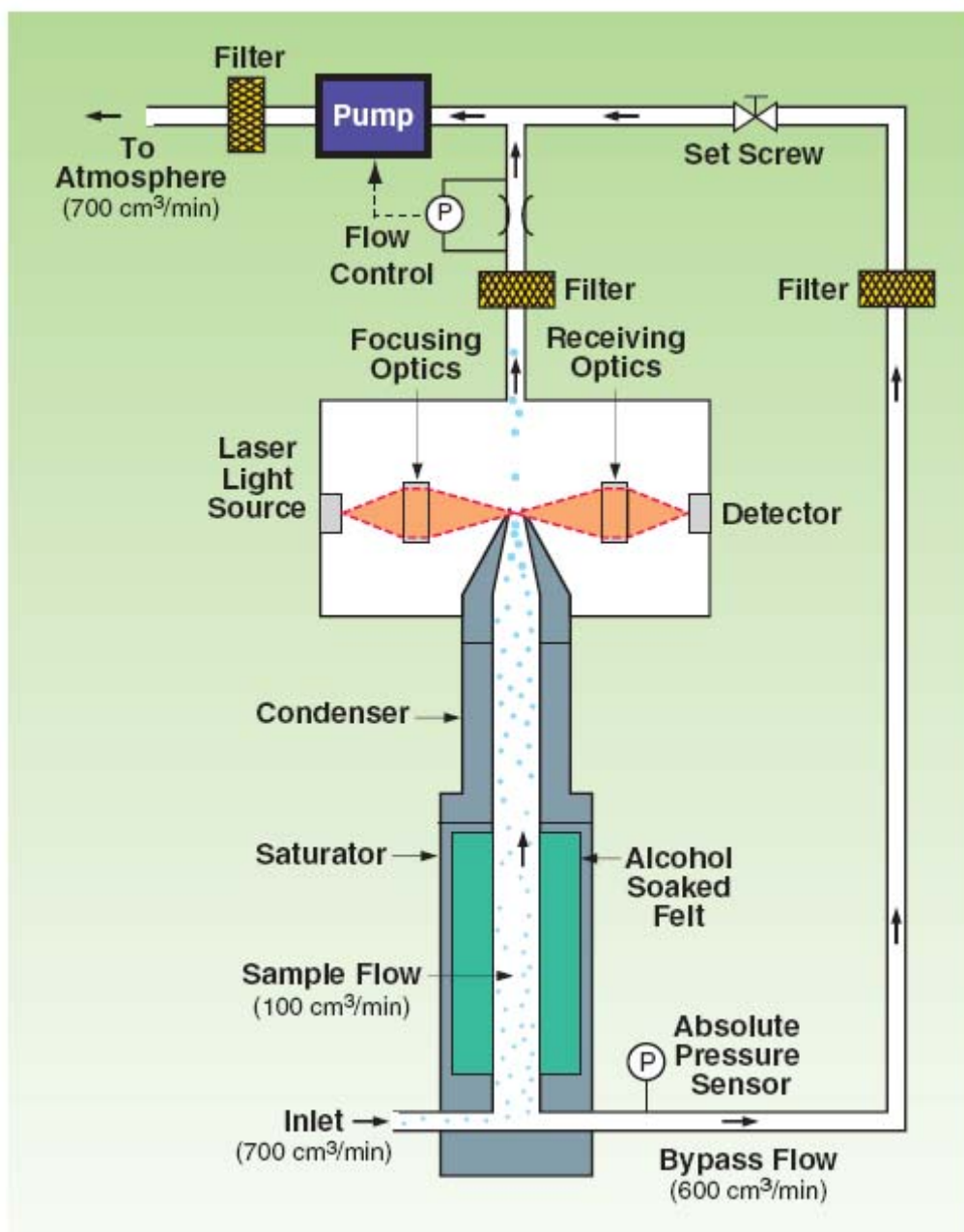
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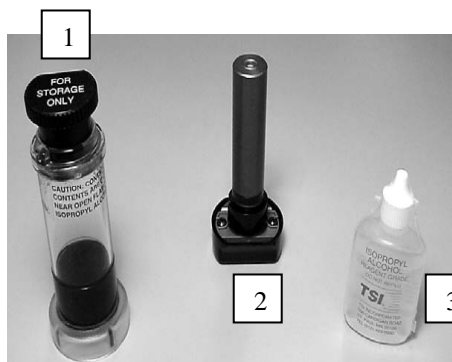
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Attachment 9.2

Condensation Particle Counter Components

**Figure 1: Model 3007 Condensation Particle Counter
With Inlet Probe Assembly, Battery Pack, and Batteries**

Item Description	Part/Model	Reference
Condensation Particle Counter	N/A	1
Aerosol Inlet Fitting (installed)	N/A	2
Battery holder	801623	3
Battery, AA, alkaline	N/A	4
Carrying case	801613	(not shown)

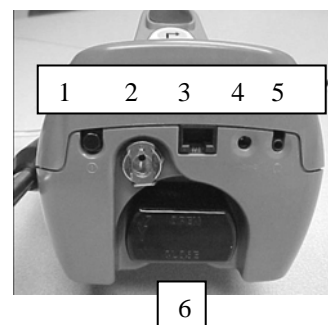


**Figure 2: Alcohol Fill Capsule with Storage Cap,
Alcohol Cartridge, Alcohol Bottles and Shoulder Strap**

Item Description	Part/Model	Reference
Alcohol fill capsule and storage cap	1083070	1
Alcohol cartridge	801624	2
30 ml alcohol bottles (1 shown)	8016	3

Figure 3: The Back of the Instrument

1. On/Off switch	4. AC Adapter socket
2. Inlet quick-connect fitting	5. Headphone jack
3. Communications port	6. Alcohol cartridge



**Figure 4: Mesh Storage Bag with Spare Wicks, Computer
Cable, Zero Filters and DB9/DB25 Adapter**

Item Description	Part/Model	Reference
Mesh bag	1380031	1
Spare wick kit	1081479	2
Computer cable, RJ45/DB9	800563	3
HEPA zero filter, with adapter	1030314	4

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Attachment 9.3

Troubleshooting

The table below lists the symptoms, possible causes, and recommended solutions for common problems encountered with the Condensation Particle Counter (CPC).

Symptom	Possible Cause	Corrective Action
Unable to obtain zero count (using HEPA zero filter)	Optics are flooded with alcohol (caused by multiple or prolonged tilting of instrument).	Let instrument run overnight (using AC adapter) with storage cap installed in CPC (<i>not</i> alcohol wick). This will dry out the optics and should restore proper operation.
	Inlet fitting is missing O-ring.	Make sure O-ring is in place on inlet fitting.
	Alcohol cartridge is loose.	Tightly install the alcohol cartridge into instrument.
	Bad HEPA filter (uncommon).	Try using a different filter. Or try using two filters inline.
	Internal leak inside instrument (very uncommon).	Must be diagnosed and serviced at factory.

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Attachment 9.3

Symptom	Possible Cause	Corrective Action
Counts seem too low (below expected values).	Low on alcohol.	Replenish alcohol in wick.
	Particle count in area really <i>is</i> low.	N/A
	Moisture buildup inside alcohol cartridge.	Change alcohol wick inside alcohol cartridge.
	Pump problem causing low (or no) flow. Instrument is being operated in wrong environment: too hot, too cold, too humid.	Listen for pump operation. Check pump flow with flowmeter: should be approx. 0.7 lpm. Operate in specified environment only.
	Inferior or contaminated alcohol.	Change alcohol wick inside alcohol cartridge. Use only approved alcohol.
Does not turn on.	Unit needs calibration and/or servicing.	Return to factory for service.
	Not pressing on/off switch properly.	Press and hold on/off switch for one second.
	Batteries are dead.	Replace batteries.
No keypad response.	AC adapter is not plugged into unit.	Connect AC adapter.
	Keypad defective.	Return to factory for service.
"LO ALC" message	Alcohol wick is depleted.	Refill alcohol cartridge.
"TILTED" message	Instrument has been tilted during operation.	Hold instrument level during operation! Condition will normally correct itself. Tilt condition may cause data logging or Sample Mode problems.
"PUMP BLOCKED" message	Sample inlet is blocked.	Remove obstruction. Press <Enter> to reset.

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Attachment 9.3

Symptom	Possible Cause	Corrective Action
"LO BATT" message	Low batteries.	Replace batteries.
	AC adapter is malfunctioning or not plugged in.	Connect AC adapter.
"LASER PROBLEM" message	Possible laser failure.	Return to factory for service.

**Safety & Health Services Division
Industrial Hygiene Group**

HP-IHP-75560

**Model 3007 Condensation Particle Counter
Job Performance Measure (JPM) Qualification Certificate**

Candidate's Name	BNL#	Date of Qualification
		Expires (3 years)

Topic	Criteria	Qualification Status		
		Not Qualified	Recovered	Satisfactory
Personal Protective Equipment	Understands the need to be aware of the potential surface contamination and airborne levels of contaminants and knows how to determine the need for PPE and how to obtain the correct PPE for the hazard.			
Sampling Equipment	Shows where equipment needed for the procedure is located and how to properly sign it out.			
Sampling Protocol	Understands limitations and care of the instrument and demonstrates knowledge of hazards posed by this instrument.			
Meter Operation	Demonstrates loading alcohol appropriately.			
	Demonstrates the proper transport and storage modes for the meter.			
	Demonstrates turning on and off, warming up, and zeroing.			
	Demonstrates use of logging feature vs. survey mode.			
Record forms	Shows how to correctly and completely fill all forms associated with this SOP.			
Analysis of data	Shows how to perform (or who to request to perform) the data analysis on the sampling data to assess potential exposure to the sampler, worker, public and environment.			

I accept the responsibility for performing this task as demonstrated within this JPM and the corresponding SOP.

Candidate Signature:	Date:

I certify the candidate has satisfactorily performed each of the above listed steps and is capable of performing the task unsupervised.

Evaluator Signature:	Date: